Prediction and Predictability of the Madden Julian Oscillation in the NASA GEOS-5 Seasonal-to-Subseasonal System

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Introduction

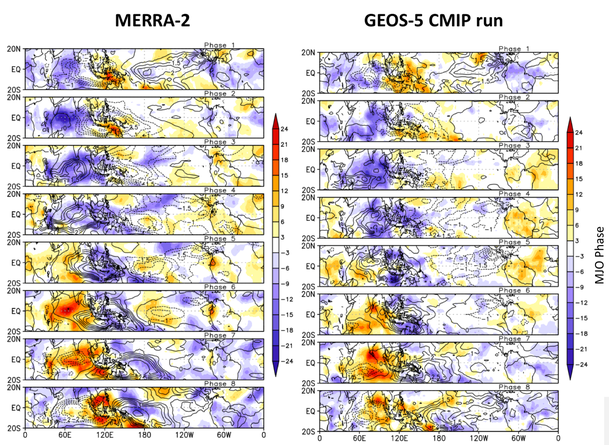
The Madden Julian Oscillation (MJO) is an important source of predictability in the subseasonal timescale. In this study, we examine the prediction skill and the predictability of the MJO in a suite of subseasonal reforecasts produced with the NASA GEOS-5 model as part of the NOAA SubX project.

Model Description

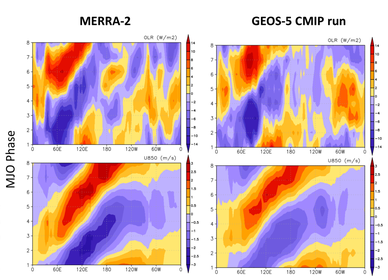
Atmosphere: NASA GEOS-5 (internal tag: Heracles h54p1c180o05_2) run at ½ degree horizontal resolution and 72 vertical layers
Ocean: Modular Ocean Model Version 5 (MOM5) of Geophysical Fluid Dynamics Laboratory run at ½ degree horizontal resolution and 40 vertical layers
Land: Catchment land surface model
Sea ice: Los Alamos Sea Ice model (CICE)
Initialization of the reforecasts: Atmosphere from the Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2); ocean and the sea ice from GMAO ocean analysis; and land from MERRA-2 land fields which are based on observations-corrected precipitation. The reforecasts are initialized every 5 days with a total of 73 start dates per year, with 7 ensemble members per start date for 1999-2015. Each reforecast is run for 45 days.

Phase composites

MJO in the free running GEOS-5 model in comparison to MERRA-2



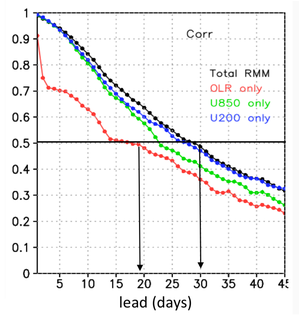
MJO RMM phase composites of OLR (shaded, W m^{-2}) and U850 (m s^{-1}) in MERRA-2 and free running GEOS-5 , the version employed in the SubX reforecasts



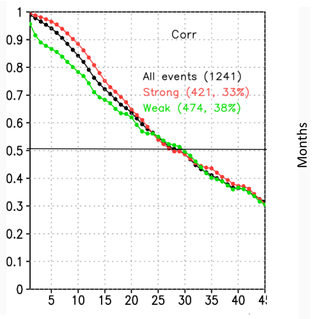
Phase composites of OLR and U850 averaged over 15S-15N

Prediction skill and predictability

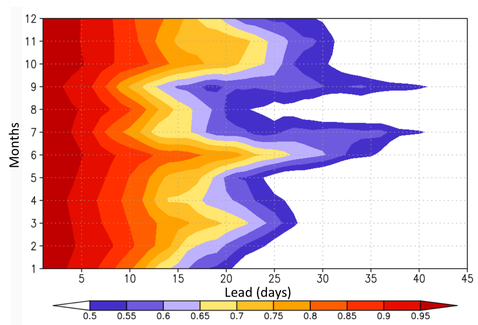
Prediction skill based on bivariate correlation of RMM indices between reforecasts and the MERRA-2



Skill for individual fields in RMM



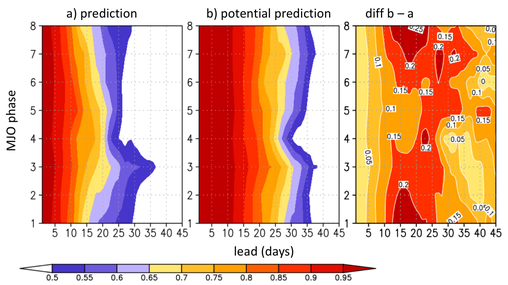
Skill for strong and weak events



Seasonality in skill

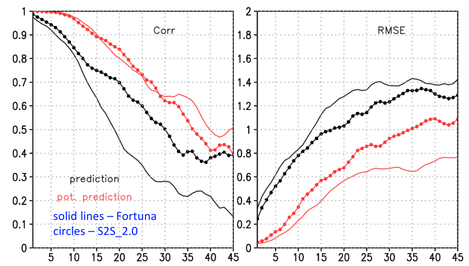
Prediction skill as a function of season shows two peaks, one in October-December and another in June-July that may be related to the Indian monsoon intraseasonal variability. With respect to the skill as a function of the initial amplitude of the MJO, the model is able to predict initially strong events slightly better than the weak events.

Prediction skill and predictability as a function of MJO phase



Pronounced increase for cases that are initialized in MJO phases 2 and 3. The upper limit of predictability is computed by taking one ensemble member as the truth and verifying ensemble mean of the rest against that. Scope for improved prediction mainly lies between forecast leads 15-25 days.

Comparison with the previous version of the GEOS-5 seasonal prediction system



Conclusions

1) The GEOS-5 SubX reforecasts show reasonably good skill in predicting the MJO. The RMM index based skill metrics show that anomaly correlation of 0.5 is reached around forecast lead of 29-30 days. The skill is increased up to 35 days for MJO events initialized in phase 3, where convection is centered in the central tropical Indian Ocean.
2) The RMM based skill mostly comes from U850 and U200 fields as opposed to OLR.
3) Strong MJO events have slightly higher skill in the first 20 days of the forecast.
4) The upper limit of the MJO predictability falls around 35-37 days. Scope for improved prediction mainly lies between forecast leads 15-25 days.
5) The SubX data show improved skill compared to the previous GEOS-5 seasonal prediction system. This could be partly due to model improvements and partly due to improved initial conditions from the MERRA-2.

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